NMT Broadband VHF Interferometer Field Campaign in Utah: First Year of Observations and GLM Comparisons

by
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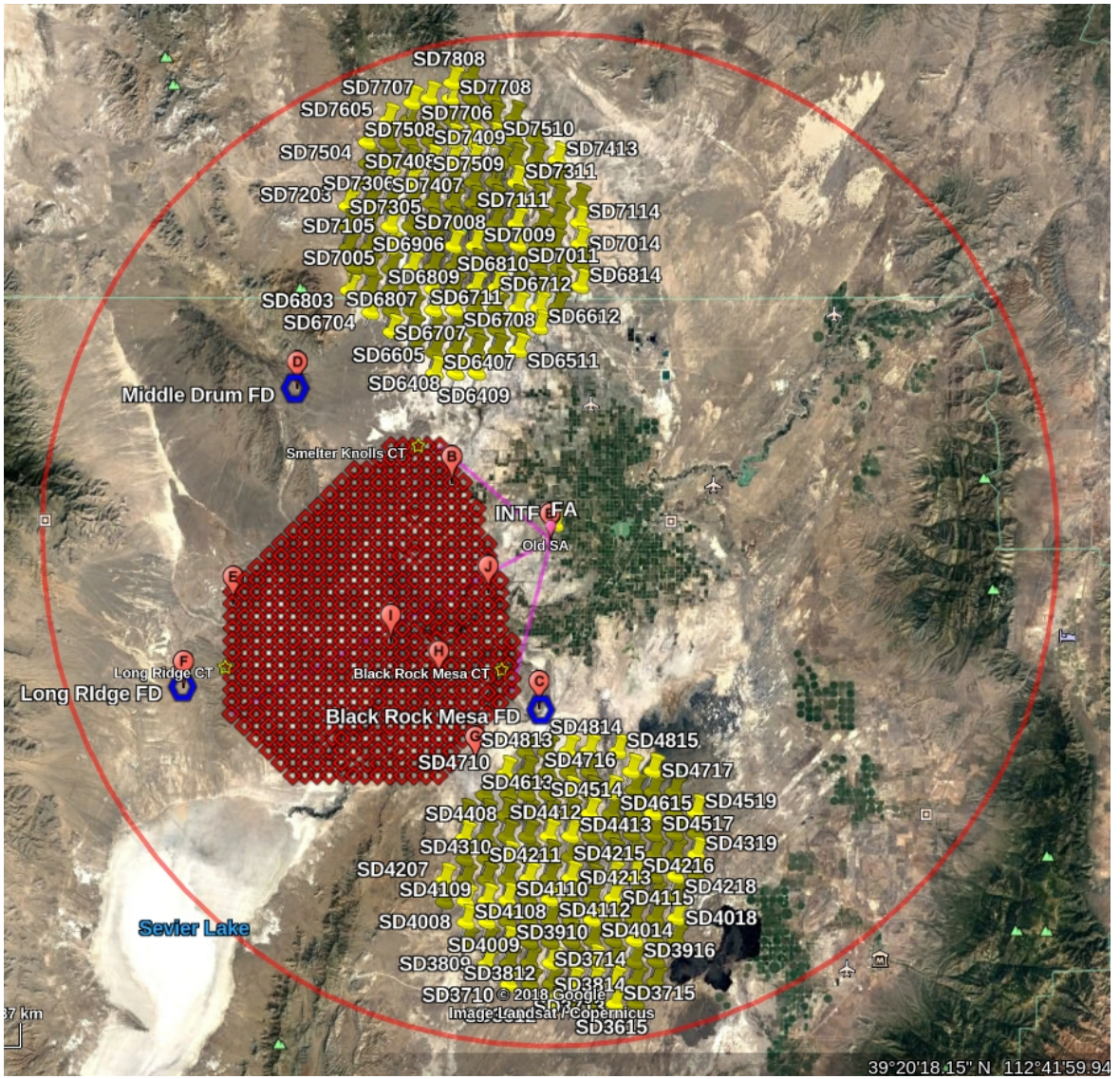
Utah Field Campaign Overview

- Dates: July 26, 2018 – Current
- Deployed near the town of Delta, about 6 km east of gamma-ray telescope array
- VHF baselines (3): 106-121 meters, deployed in a near equilateral triangle
- Fast antenna electric field sampled with VHF
- TGFs: 8 downward-directed terrestrial gamma-ray flashes captured so far (2018: 4, 2019: 4)

Utah Field Campaign Overview

- The main array (red) has 512 detectors in a 1.2 km grid, covering an area of over 700 km^2
- Major expansion of telescope array to north and south (yellow) in the Spring & Summer of 2019
- The new array grid spacing is roughly double (2.5 km) that of the main array



Telescope Array Surface Detector

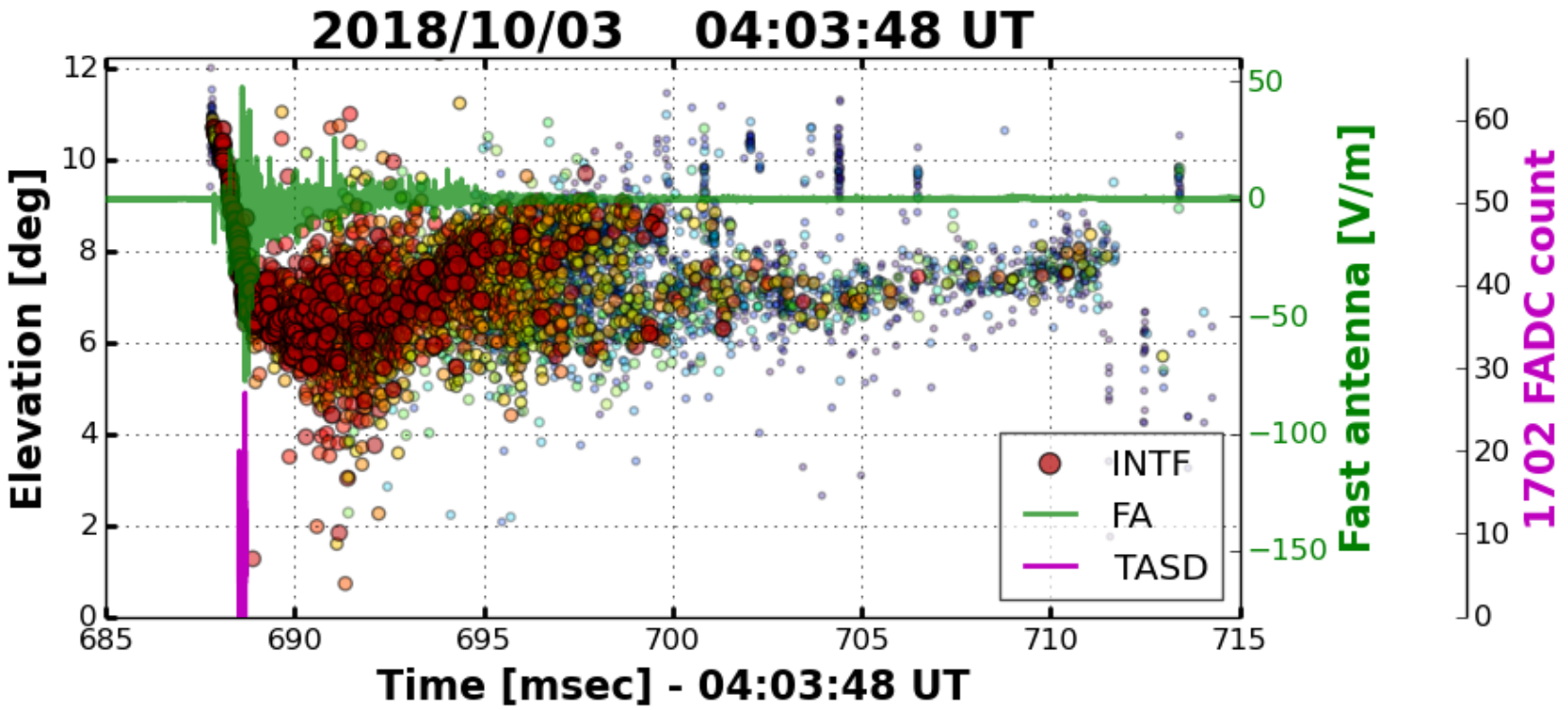
- Each detector is composed of two 1.2 cm thick plastic scintillator slabs separated by a 1mm inch steel plate
- When 3 or more adjacent detectors detect a sufficiently strong signal within 8 μs, waveforms are stored from all nearby detectors (under the assumption that it's a cosmic ray shower)
- More often than not, TGFs are comprised of multiple triggers. A scan for such bursts locates a TGF ~50% of the time

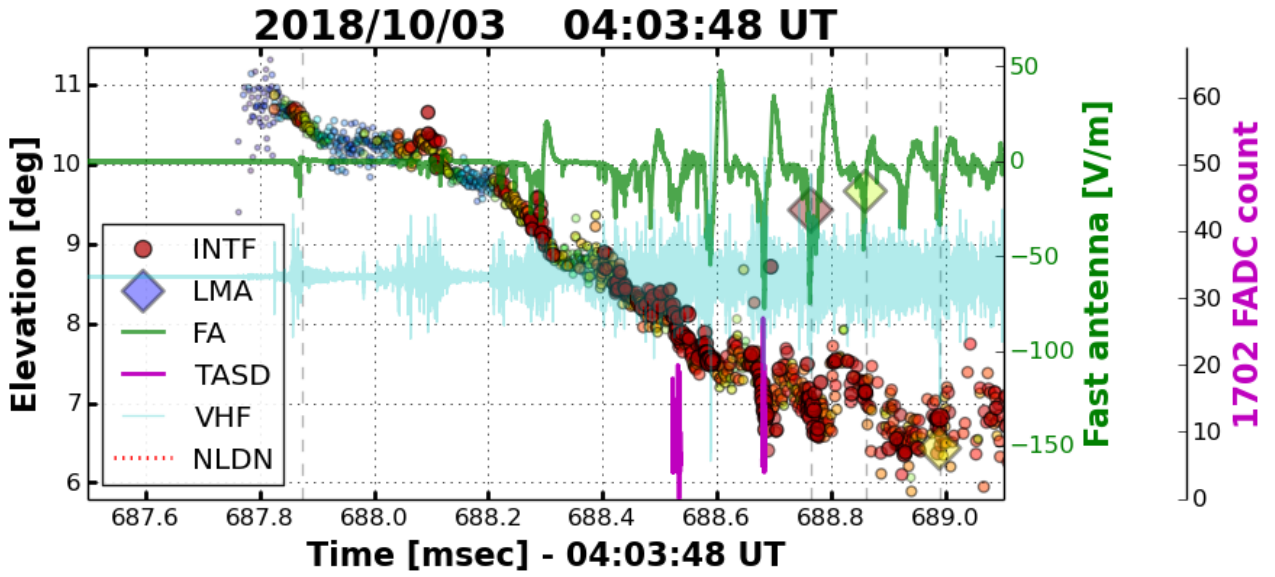
Utah Lightning Characteristics

- Summer: western edge of monsoonal flow. Mainly air mass storms with normal polarity lightning.
- Late spring / Early fall: frontal activity with mostly normal polarity lightning
- October to mid-April: low-level (inverted) ICs dominate. Some highly-energetic (>100 kA) -CGs also noted in mid-January.

October 3, 2018 – 04:03:48 UT

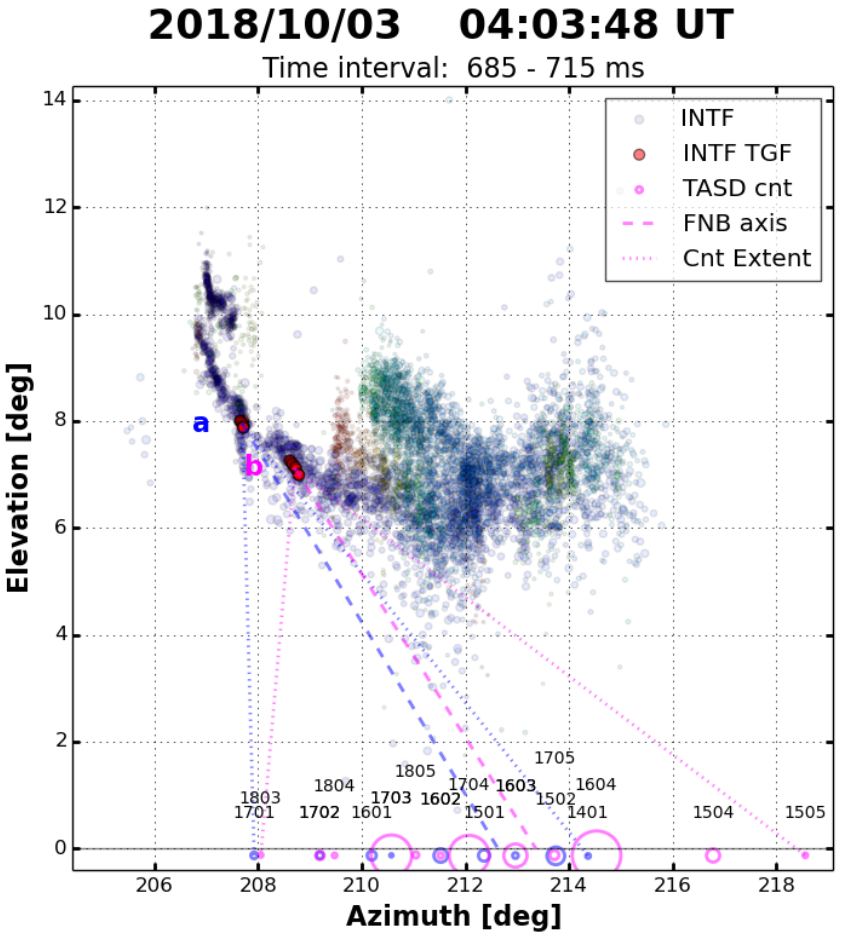
- A TGF burst was detected over the southern part of the telescope array at ~24 km range from the INTF (according to the LMA)
- The burst occurred in association with the preliminary breakdown phase of a low-level intracloud discharge


2018/10/03 04:03:48 UT
Elevation [deg]
Fast antenna [V/m]
1702 FADC count
Time [msec] - 04:03:48 UT
INTF
FA
TASD

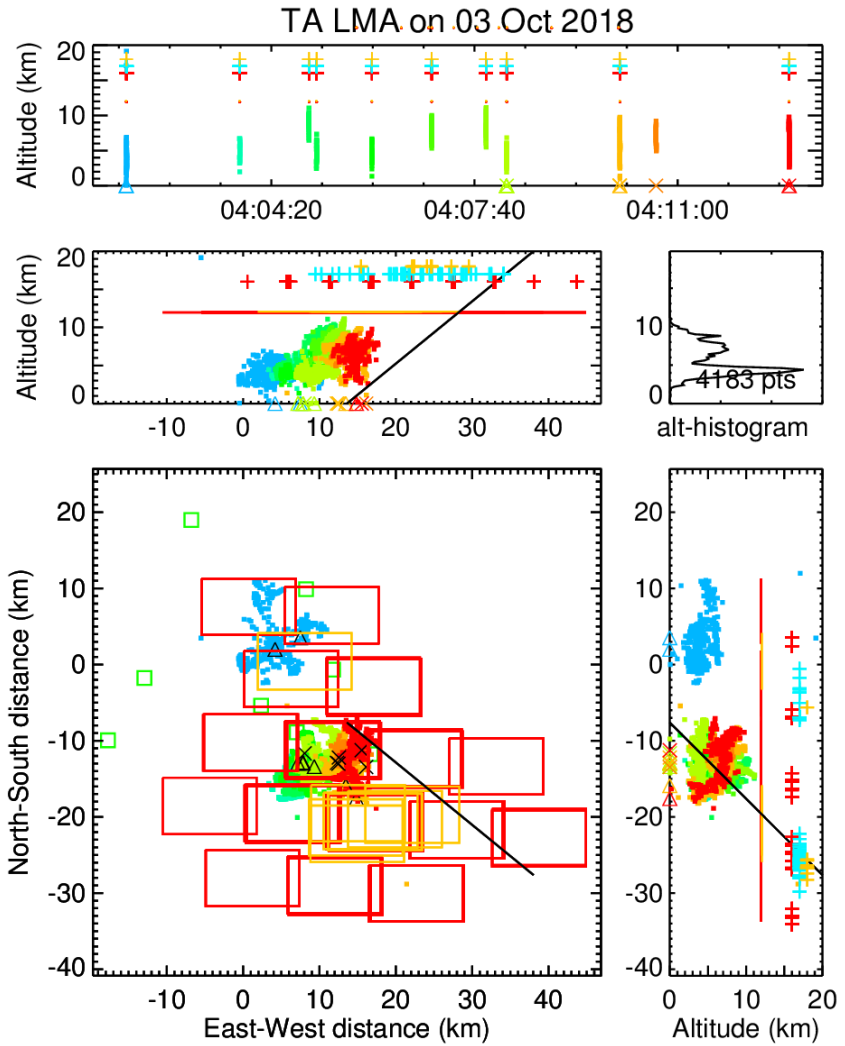

2018/10/03 04:03:48 UT
Elevation [deg]
Fast antenna [V/m]
1702 FADC count
Time [msec] - 04:03:48 UT
INTF
LMA
FA
TASD
VHF
NLDN

October 3, 2018 – 04:03:48 UT

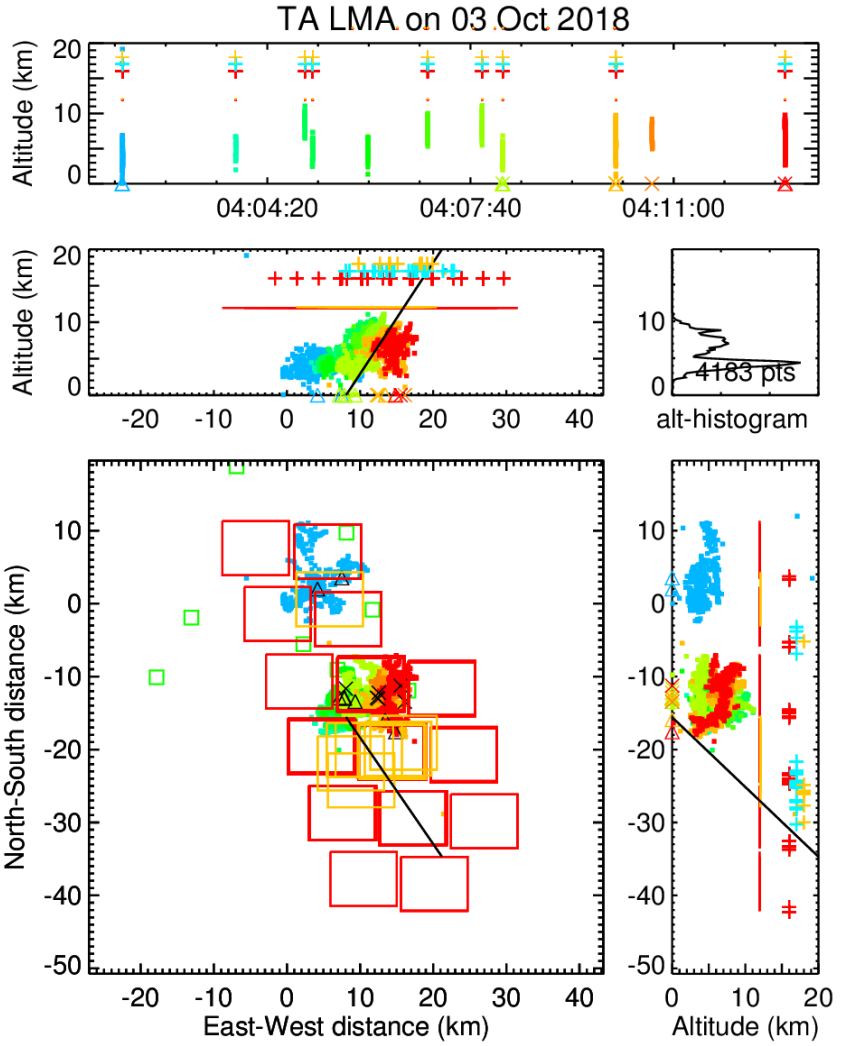
- The initial development is very fast with an average speed in excess of 10^6 m/s
- There is a significant non-vertical tilt to the fast negative breakdown (FNB) events associated with gamma-production (opaque red circles)
- The highest TASD counts (open circles) are oriented along the FNB beam axes (dashed lines)



GLM of storm: GOES 16 vs GOES 17

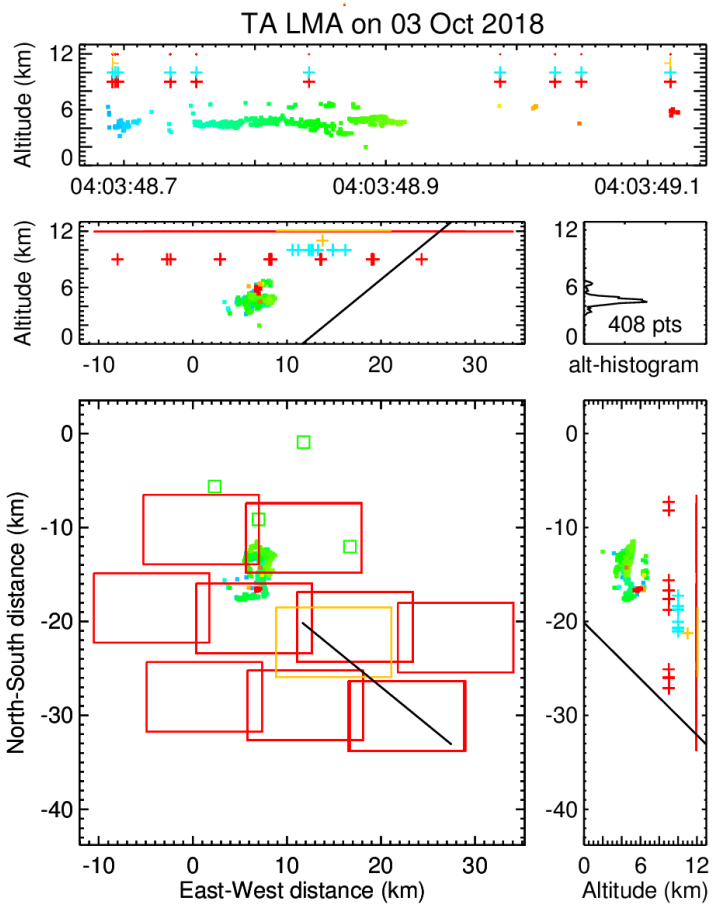


GOES 16: 91% flash detection efficiency within interval (night-time)

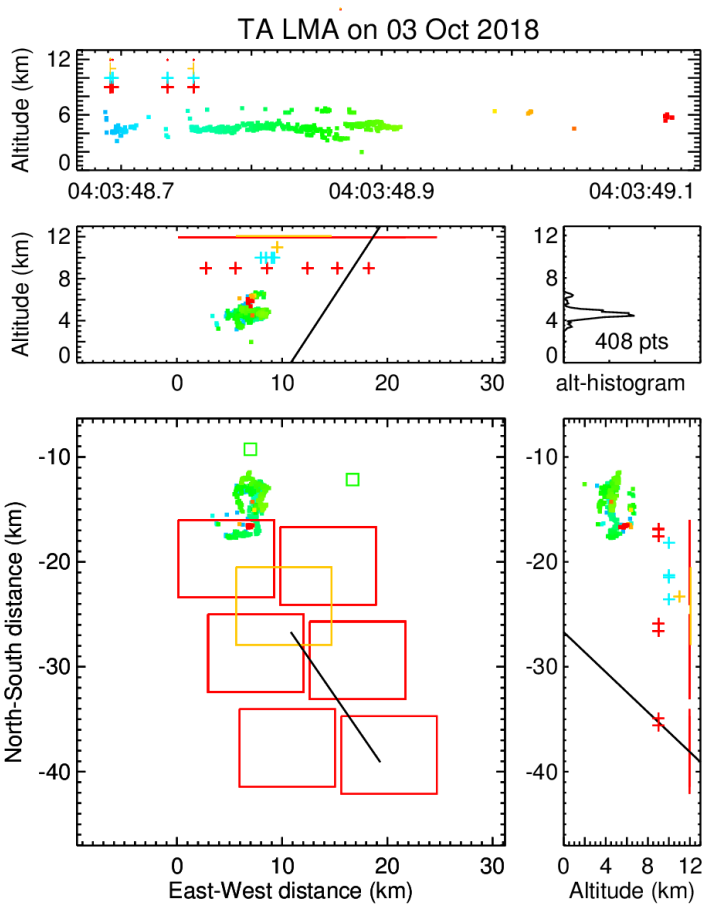


GOES 17: 82% flash detection efficiency within interval (note: predates drift)

GLM of TGF flash: GOES 16 vs GOES 17



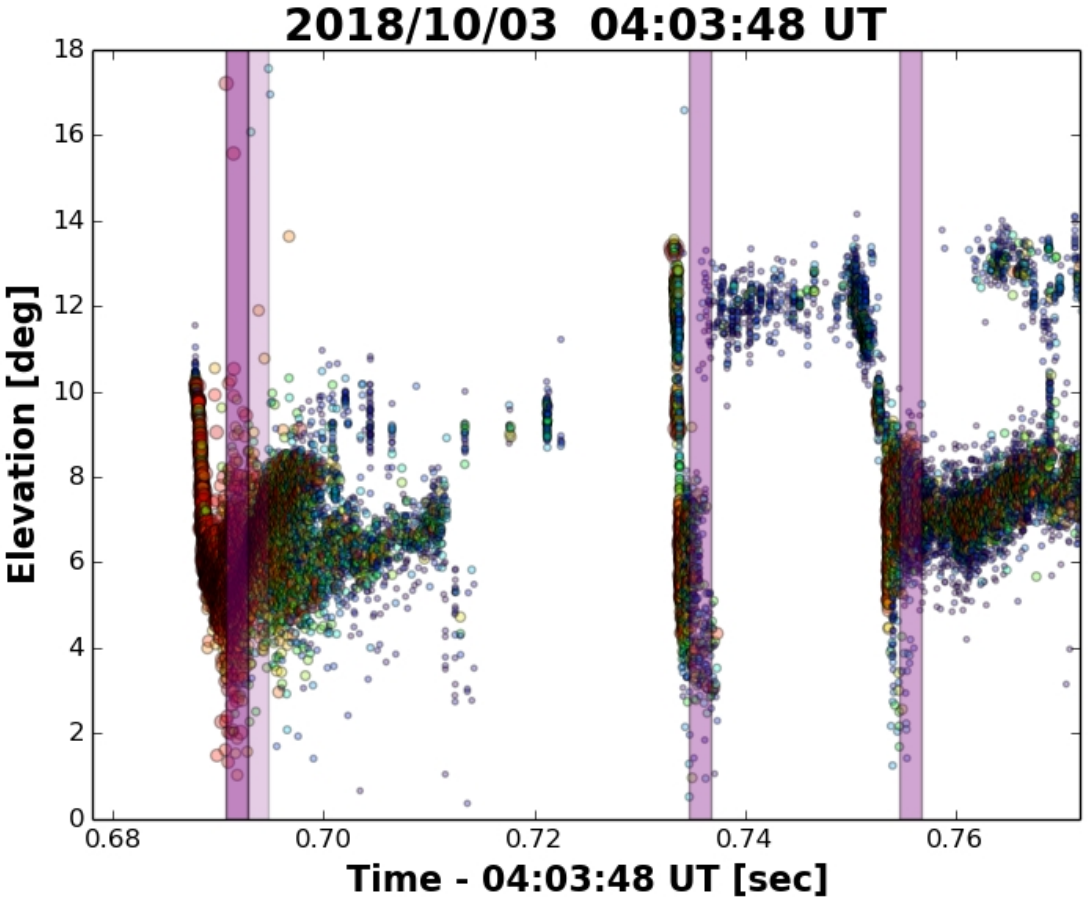
GOES 16: Low-level leader activity is detected as well as late-phase K-changes (note: storm top is around 11 km)



GOES 17: Only low-level leader activity is detected, though at similar times to those detected by the GOES 16 GLM

INTF–GLM comparison for low-level leader activity

- The largest number of pixels illuminated (darkest purple bar) is in the initial energetic breakdown phase (note: the actual first event may have been pitched by the GLM algorithm)
- All of the detections are correlated with negative leader branching as they reach their lowest extent



INTF-GLM comparison: Questions

- What role does negative leader dynamics (speed, splitting, etc) play in the likelihood of optical detection?
- Is light from the October 3rd flash primarily escaping from the bottom (and perhaps side) of the cloud?
- Why do some western storms have high GLM flash detection efficiencies and others are very poor (as shown in the next couple of presentations)?